Pre-Retrofit Evaluation of Industrial Projects

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ABSTRACT

NYSERDA's Industrial and Process Efficiency (IPE) Program provides technical assistance and installation incentives to manufacturing, agricultural, mining, wastewater, and data center customers. Larger IPE projects tend to feature measures that change the manufacturing process. In such cases, incentives are based on a reduction in energy usage per unit of production or workload.

Through the pre-retrofit review process, NYSERDA's impact evaluation contractor works with program implementation staff prior to measure installation to review a sample of the largest projects, particularly those that involve process-specific baseline definition. The evaluators' pre-installation activities include site visits, review of savings calculations, writing early evaluation assessment reports, and periodic meetings with program implementation staff and NYSERDA's technical review contractors.

The benefits of pre-installation evaluation include:

For evaluators: Increased engineering rigor and quality

- Evaluation engineer inspection of equipment in its pre-retrofit state
- Input regarding program-required pre- and post-retrofit metering plans
- Better understanding of baseline alternatives at the time of decision-making

For program administrators: Increased likelihood that reported and evaluated savings will be similar

- Increased depth of engagement with project facilitators
- Early discussion and usually convergence between program and evaluation baseline characterization
- Adjustment to program savings calculations prior to incentive commitment

The cost of these benefits is additional time requirements by all parties. This paper shares lessons learned and analytical techniques used to ensure that evaluators and program administrators considering this new process elsewhere gain the benefits and avoid the pitfalls of real-time program feedback. It also identifies some of the more interesting policy issues concerning a pre-installation review as the evaluation 'bleeds' into the implementation – a goal actively promoted by some industry advocates.

Industrial and Process Efficiency Program Description

NYSERDA's Industrial and Process Efficiency (IPE) Program provides technical assistance and installation incentives to manufacturing, agricultural, mining, wastewater, and data center customers. Larger IPE projects tend to feature measures that change the manufacturing process or increase capacity. In such cases, incentives are based on a reduction in energy usage per unit of production or workload. Eligible facilities may also apply for incentives for non-process measures. Incentives are available for the implementation of both electric and natural gas projects that include custom and site-specific commercially available energy efficient technologies. Both existing and new facilities are eligible to

[1] Any opinions expressed, explicitly or implicitly, are those of the author and do not necessarily represent those of the New York State Energy Research and Development Authority.

participate in the IPE program.

The NYSERDA IPE program is maturing. It started as a spin-off from a general commercial/industrial incentive program in 2009 after the industrial process segment of the New York market was identified as having high savings potential. The majority of projects in the first two program years were lighting and compressed air upgrades. The complexity of the projects has increased in the last 2 years and the program is now receiving more large, custom, and process-specific energy efficiency measures. The program has received applications for more than twenty-five projects with more than 5,000,000 kWh/yr in expected annual electric savings and more than forty projects with more than 10,000 MMBtu/yr in expected annual natural gas savings through June 2012.

The program requires that the participant fund and conduct pre-and post-installation measurement of equipment performance on all lighting projects with reported savings of more than 1,000,000 kWh per year, all other projects with reported savings greater than 500,000 kWh per year, and all natural gas saving projects with savings greater than 10,000 MMBtu/yr. This measurement and verification (M&V) is to ensure the program is garnering expected savings. The customer's final incentive payment is based on the savings estimated after the program-required M&V process is complete.

Pre-Installation Evaluation Methodology Background

In 2011, after its first 2 years of operation, the IPE program received a conventional post-retrofit-based impact evaluation. The results were favorable[2], but it was clear that projects were growing in complexity and size, making the program vulnerable to more dramatic differences between program reported and evaluated savings in the future. To mitigate the potential for deviations, the evaluation and program teams started working side-by-side to review the biggest projects earlier in the project development cycle. Gradually, the concurrent evaluation approach was formalized with three goals:

1. Review the program's pre- and post-retrofit measurement plans and identify any evaluation-driven need for additional data collection that the program is not already performing. The evaluators will either perform the additional data collection or have the applicant do so to ensure that the evaluators can calculate energy impacts.
2. Give the evaluators the opportunity to review the program administrator baseline and provide concurrence or an alternative baseline characterization as early as possible and share it with program staff.
3. Review the program administrator's savings calculations and assumptions for reasonableness and provide feedback.

Implementation of these challenging goals has proved beneficial. The benefits include the ability of the evaluators to provide early feedback to program staff regarding baselines and planned M&V methodologies. Further, the concurrent nature of the evaluation review has led to greater process efficiency and less customer survey fatigue. This paper details the process undertaken in these pre-installation reviews, outlines the challenges faced, presents several example review projects, and shares lessons learned and recommendations for this process.

If executed as planned, the pre-installation review process should increase consistency between the program and evaluation in M&V baseline definition, methodology, and data collection without introducing bias into the evaluation. Free ridership assessment is not part of the process; further discussion on this topic is included later in this paper.

[2]The evaluated savings realization rate was 1.01 on electric energy savings and 1.14 on natural gas savings. The electric energy savings error ratio was 0.33 (Megdal Team, 2012).

Pre-Installation Review Process

As of March 2013, the Impact Evaluation Team has been actively involved in fifteen pre-installation reviews. The evaluators performed reviews of program documents and technical assistance calculations on all fifteen projects and executed eight site visits.

The evaluation team proposed, and with the input of the administrators, finalized a formal pre-installation review process. It consists of the following steps:

1. **Early identification of candidate pre-installation review projects.** Program staff identifies projects meeting the following criteria:
    a. All projects over 5,000,000 kWh/year or 10,000 MMBtu/year expected savings, and
    b. Projects with over 1,000,000 kWh/year or 5,000 MMBtu/year expected savings that also have complex technical characteristics such as:
        i. Process changes,
        ii. Complicated baseline definition, such as that due to capacity expansion
        iii. Controls upgrades, or
        iv. Program staff has concerns about possible overlap between free ridership and baseline definitions.

2. **Review of pre-installation energy analysis reports.** Although the goal of this process is pre-installation review, because the process was newly implemented, the evaluators have received candidate projects in all stages of implementation. Evaluators have received project information as early in the process as the time of initial savings estimation by the applicant, before the project's initial energy analysis has been formally reviewed by NYSERDA. Evaluators also have received projects at later stages of development, including those that are already installed but are awaiting the program-implemented M&V. Projects that are received prior to implementation are reviewed for (1) appropriateness of baseline characterization, and (2) planned M&V approach. A third step, (3) review of reasonableness of energy efficiency calculations, was added after early pre-installation review experience revealed the benefits of up-front calculation review.

    There are limits to the extent to which evaluators can determine the baseline in advance of project completion. Specifically, evaluators can assess existing conditions, determine if the project is a retrofit or new construction, and, through interviews with applicants and vendors, determine the *baseline equipment* that constitutes the least-efficient commonly used baseline solution.[3] The most challenging aspect of this process is often the characterization of a baseline for new construction or process expansion projects where no publicly available industry benchmark of current practices is available.

    While conclusions can be made regarding the baseline configuration, the evaluators cannot definitively determine or affirm the *baseline energy use* because post-installation hours of use and loading are unknown and will vary from projections.

    Every review includes at least one conference call with IPE program staff and, typically, their technical assistance contractor followed by a series of data requests and data exchanges.

3. **Site visit.** The pre-installation review process includes at least one site visit to verify the pre-installation site conditions at existing facilities and the post-installation site conditions at new facilities. A second site visit may also be warranted in cases where it is necessary to verify the post-installation conditions at existing facilities.

[3] See Maxwell, 2011 for a detailed description of the recommended baseline definition procedure.

4. **Evaluator pre-installation metering.** The evaluators originally expected to need to perform pre-installation metering to collect data not in the program team's M&V plan or for which the program team did not have metering equipment. While this is still a possibility, for every project so far direct metering by the evaluators either has not been necessary or has not been possible due to customer sensitivities. The evaluators have tried to infringe on the customers as little as possible during the sensitive period before project installation, and the program team has been supportive in meeting the evaluators' expanded data requests. Both the program staff and their contractors have been extremely cooperative in this regard.

5. **Evaluator submission of a review memo.** The evaluators provide program staff with a memo summarizing the pre-installation evaluation review findings. This memo serves multiple purposes: (1) it documents the review process undertaken by the evaluators and their findings, (2) it provides a formal avenue for feedback with program staff, and (3) it provides a summary of pre-installation review findings for any future post-installation evaluation activities at the site. In some cases, multiple memos may be developed over the course of a project. The first memo is submitted prior to measure implementation, and a second memo is submitted after post-installation M&V is performed by program staff. While the memorandum does not guarantee that the evaluation interpretation of the project savings will not change for final post-retrofit evaluation, the evaluators do commit to using the described characterization of the baseline in ex post evaluation if the project proceeds as described in the application. Otherwise, the program could potentially be subject to "double jeopardy" in the sense that the baseline could be judged by the evaluators two times differently for the same condition.

   The memo is a notice of the evaluators' findings; it is not an order. As such, the IPE program administrator is not required to change the ex ante savings calculation methodology, assumptions, or pre-installation baseline characterization to reflect the evaluator notice. Additionally, this information is not required to be used when determining incentive levels and reporting savings. However, administrators understand that virtually every project in the pre-installation sample will be in the post-retrofit evaluation sample (because of their large size) and the evaluators' position on baseline in particular has been articulated and is unlikely to change. Consequently, the IPE program administrator may choose to anticipate development of additional information later to bolster the case for a less efficient baseline, or believe that an evaluator-recommended load factor is too low for a particular application, for example. The authors of this paper are aware of other jurisdictions that make the evaluators' ex ante conclusion absolute.

6. **Tracking.** The status of projects and reviews is tracked via conference calls and emails between individual evaluation project review leads, NYSERDA program managers, and technical assistance providers throughout the review process. In addition, monthly meetings are held between evaluation and program staff leads to ensure that both parties are up to speed on project statuses and key deliverables.

   Projects that have been subject to pre-installation evaluator activities are characteristically different from those that have not been through this review process. The evaluators track projects that have been through the process and will group them as a distinct stratum in the next retrospective impact evaluation. To date, this rationale has been academic because reviewed projects all have been so large that they are certain to be in a census stratum of a stratified ratio estimation design anyway, but the principle is important because that may not always be the case.

The pre-installation review process is summarized in the following flow diagram.

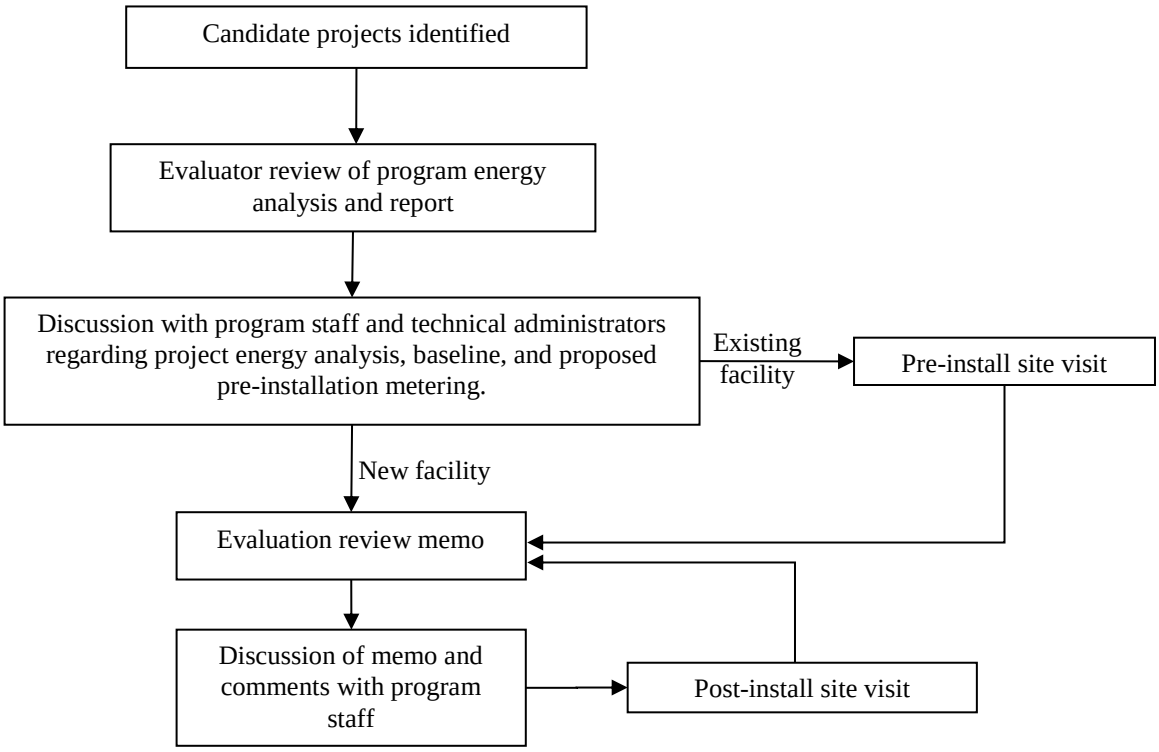

Figure 1: Evaluation Procedure for Projects Receiving Pre-Installation Review

Cost Considerations

The pre-installation review process has demanded administrative resources from the program administrator team beyond that which would have been required in a conventional post-installation-only impact evaluation. The majority of the program administrators' extra time spent early in the project cycle is not offset by time savings later. Time is required to identify projects, collect and deliver information, hold liaison meetings, and participate in monthly pre-installation tracking and management meetings with the evaluators. The process also has prompted meetings within the program administrator team.

The same is true to a lesser extent for the evaluators. Pre-installation evaluation adds steps to the evaluation process. While there is more offset for the evaluators than administrators—gaining understanding of the measure's proposed technology only happens once, whether it is sooner or later, for example. In addition, there also is a material amount of added technical and coordinating effort. This must be regarded as a net added cost item. To date, the typical pre-installation review process has required about 60 hours of evaluator time per project. The evaluators expect that about half of that time would otherwise have needed to be invested later in a post-installation evaluation and is not a marginal added cost to the evaluation.

Significant effort has been made to minimize the additional burden on the participating customers. The evaluators have scheduled all site visits thus far so that evaluation engineers accompany the administrator or their technical assistance contractors during site visits. Thus far, additional metering requirements have been modest. The most significant effect on applicants has been real but invisible to them: Early evaluator involvement sometimes has affected the committed incentive levels. The IPE program is performance-based and has substantial pre- and post-retrofit M&V requirements. This program design makes "piggybacking" of evaluation possible. For programs without such a preexisting mechanism, the addition of pre-installation evaluation would escalate requirements on customers markedly.

Lastly, the involvement of the evaluators prior to project installation means that there will be evaluation costs that are unrecoverable when a project or measures do not matriculate. To date, this has happened two times out of the fifteen pre-installation projects reviewed, which has added about 10% to the effective unit cost per evaluated site.

The authors believe that the benefits of the process generally, and the prospect of reduced uncertainty regarding gross savings estimates in particular, make these marginal added costs worthwhile. Nonetheless, the added cost means that this process needs to be applied selectively. The above procedure is applied only to the largest and most complex projects. There likely are smaller projects that would benefit from the reviews, but economics prevent review of each.

Pre-Installation Evaluation Challenges

The pre-installation review process is relatively new to the impact evaluation process and, as with any new process, there are challenges. Some of them have included:

- **Project sampling.** Currently the evaluators rely on IPE program staff to identify candidate projects according to the above protocol. An alternative would be to require that the program provide the evaluators with the tracking database regularly and have the evaluators select projects for pre-installation review. The approach currently used is far more efficient and to date it has had no negative ramifications regarding potential bias. Every project selected has been so large that it would have been included in a census selection in any post-retrofit evaluation sample design scenario. However, there may be some lost opportunity for the evaluators to review smaller but precedent-setting projects that do not meet the project size criteria of the evaluation protocol. So far, the trade-off has been deemed worthwhile.
- **Timeliness and flexibility.** The evaluators are less accustomed than program administrators in dealing with the external time restrictions, coordination pressures, and dynamic nature of pre-retrofit activity. It is common, in the early stages of project design and application, for the scope, savings predictions, or incentive structures to change. These changes result in delays or acceleration of a project. For the process to be effective and to limit the disruptions to the customer, the evaluators must recognize the need to respond quickly and on short notice to hit milestones. Similarly, for the evaluators to respond in a timely manner the program administrators must keep the evaluators well informed. This requires a great deal of coordination and communication between program administrators and the evaluators.
- **Dispute resolution.** Because the evaluators and program administrators will not always agree with or have the same interpretation of the logic that is used to estimate savings, it is beneficial to have a collaborative procedure that requires evaluation and program staff to work together in resolving any differences of opinion. This dispute resolution process facilitates discussion that results in collective understanding of the logic used by the evaluators to estimate savings. This process is especially important in instances where evaluator logic may appear contrary to common sense to non-evaluators. Likewise, the evaluators have learned to appreciate the practicalities of operating in a real-time environment and the challenges faced by the administrators when estimating ex ante savings. However, even with a full understanding of perspectives and goals, and an accepted baseline decision-making policy flow chart, there have been disagreements on interpretation of baseline that pre-installation involvement has not resolved.
- **Long individual project timelines.** Complex and expensive projects often have an incubation period of multiple years. This can be a challenge to maintaining constructive evaluation involvement and feedback, especially in cases where evaluation contracts expire or undergo substantial changes. This is a general concern and it has not been the case for the particular program and evaluation contract addressed in this paper. However, in the event of a contract change, a prospective hand-off of an active project under evaluation is possible.

- **Baseline and free ridership.** As noted above and below, free ridership is not in the scope of this program's pre-retrofit evaluation. However, baseline determination is a focus of these reviews and careful consideration is given to projects when assigned the appropriate baseline definition absent the investigation of free ridership. Distinguishing between the two is not always as easy as it seemingly should be. Adding it to the scope would increase the cost.

Case Studies

The following are examples of measures and projects that have been part of the pre-installation review process and that have been subject to the procedures and introduced some of the challenges noted above.

Case Study #1: Collaborative M&V Development and the Pitfalls of Early Involvement when Projects are Still Evolving

This project illustrates two pre-retrofit evaluation issues: (1) Program administrators and evaluators worked collaboratively to arrive at a mutually agreed upon M&V approach and (2) significant effort was expended on the evaluation of measures that did not follow through to post-installation M&V.

The project included the proposed installation of a condensing economizer and controls system at a chemical manufacturing facility. The project originally projected more than 100,000 MMBtu/yr in natural gas savings. This was reduced to 10,000 MMBtu/yr when the site elected not to implement the largest measure, the condensing economizer. The program M&V approach originally proposed to utilize pre- and post-retrofit whole-facility metered natural gas data to determine project savings for both measures. Evaluators reviewed the proposed approach and available metered data and, with consideration of the lower projected savings absent the condensing economizer measure, noted that the reduced magnitude of energy savings for the controls system measure alone was within the typical variation in natural gas use observed at the facility, decreasing the viability of a pre- vs. post-retrofit natural gas use analysis approach. This observation was shared with program administrators and technical reviewers along with recommendations to collect additional data and perform an engineering analysis to validate M&V savings. Program administrators were receptive to this feedback and the planned M&V approach was updated accordingly.

After installation the facility indicated to NYSERDA that they were dissatisfied with the operation of the new controls system and planned to discontinue its operation. NYSERDA continued to support the customer, and additional energy efficiency measures have been identified. Program administrators and evaluators are applying the lessons learned and information gathered in the pre-retrofit review of the original two measures to the development of mutually agreed upon savings calculations and pre- and post-install M&V strategies for the new suite of measures.

Case Study #2: Resolving Differences

In at least one instance evaluators have accepted program staff recommendations on points where the two perspectives differed. This project included the installation of a heat recovery system on a chemical distillation process. The evaluators proposed the inclusion of periodic spot measurements to verify pre-installation conditions. Program staff pointed out that such spot measurement would need to be taken manually by the customer and would be burdensome to collect. The evaluators and program staff discussed the benefits of collecting the requested information and the uncertainty introduced into the analysis by omitting this manual data collection. Ultimately, the evaluators and program administrators agreed to remove the recommended points from the pre-installation M&V, as the burden of acquiring the data outweighed the uncertainty associated with its omission.

Case Study #3: Windows of Opportunity

The level of pre-installation involvement by engineers must be flexible and is affected by timing. This project is one where the evaluators were not involved before measure implementation, and this impacted the evaluators' review of the project, especially the project baseline.

This project includes the implementation of a new production line at a beverage manufacturer. The project was not submitted to NYSERDA until it was virtually ready for installation, which prevented the evaluators from performing a pre-installation site visit or metering. This project is currently installed and undergoing post-installation review and M&V plan development. The evaluators have provided feedback to program administrators and technical assistance providers regarding the project and have noted issues with the project baseline that could have a significant impact on the evaluated savings. This baseline discussion is challenging for many reasons, one of the most significant of which is that it requires details from site staff regarding market effects and alternative baselines to inform the appropriate baseline. In instances such as this where such discussions are not possible due to accelerated project timelines, baselines and pre-installation conditions must be reconstructed after the fact, which is both challenging and in some cases impossible. In the case of this project, data collection and discussions between program administrators, technical assistance providers, evaluators, and site staff are ongoing and the evaluation project baseline has yet to be finalized.

Case Study #4: Starting the Conversation Early

In several instances, program staff have introduced projects to the pre-installation review process that are so new that formal energy savings analyses have not been developed at the time of review. Including projects at such an early stage in their development provides evaluators and program administrators the opportunity to collaboratively review and discuss big-picture issues that may affect the project energy savings and M&V.

The example detailed here is a large data center project affecting multiple locations. The project involves multiple measures with potentially interactive affects and varying baseline types. The evaluators reviewed preliminary project descriptions and provided feedback for discussion between evaluators, program staff, and the project's technical assistance provider. The evaluation feedback included questions regarding measure differentiation, baseline definition, understanding the project timeline, and what opportunities existing for pre-installation M&V.

Initiating the review process at such an early stage in the process has benefits for both evaluators and program staff. The evaluators are able to gain an understanding of the project and raise any potential red flags, while program staff members have the opportunity to probe evaluators regarding specific pre-installation issues such as baseline and proposed M&V strategies. This improves the odds that evaluators and program staff will be able to reach common ground on issues of baseline and proposed M&V.

Pre-Installation Review Activities in Other Jurisdictions

Pre-installation review is gaining attention from evaluators and program administrators as a tool for increased collaboration, education, and proactive evaluation of projects, especially for large custom commercial and industrial energy efficiency programs. The evaluators are aware of pre-installation review activities going on in at least two other jurisdictions and with at least one other NYSERDA program.

The ex ante review process in California is implemented by the California Public Utility Commission (CPUC) and its consultants, and includes pre-installation review of custom commercial, agricultural, and industrial projects. Given the evaluators' experience with this process in California, it technically differs from the NYSERDA IPE pre-installation review activities in the following significant ways:

- **CPUC ex ante consultant findings are final, not advisory –** Both the CPUC and NYSERDA pre-implementation review processes seek to provide program implementers with early feedback for the purposes of education and the calculation of ex ante savings values. However, the two processes differ in how review recommendations are adopted by program implementers. If the CPUC reviewers find that the ex ante savings for a project differ from the savings projected by the investor owned utility (IOU), and the two are not able to arrive at a common ex ante energy savings value, the evaluator savings is adopted. However, the IOUs always have the ability to raise its objections to Energy Division (ED) management for a resolution. This differs from the approach implemented in the NYSERDA IPE pre-installation review process, in which savings adjustments or changes made by evaluators are recommendations, not mandates. Program administrators may or may not elect to adopt the evaluation recommendations. In most cases, the program administrators and evaluators have been able to arrive at a common understanding, but the possibility exists that the evaluation and program savings for a project may differ at the conclusion of the pre-installation review process.
- **Free ridership –** The CPUC ex ante review process includes interviews for free ridership and early quantification of a net to gross ratio (NTGR) for projects. This information is shared between the ex ante review team and the IOUs. The ex ante review team cannot exclude projects from program participation based on a low NTGR, but the IOU that is in charge of incenting the project may elect to reject it based on the evaluators' free ridership interview results. Such sharing of the NTGR results by NYSERDA evaluators with program staff is not permissible on a project-specific basis in order to protect respondent confidentiality. To date free ridership interviews have been omitted from the NYSERDA IPE pre-installation review process.
- **Formality of Communication –** The evaluators have found that the ex ante review process in California requires a great deal of formal document submission due largely to the business relationships of the various parties. The ex ante reviewers are contractors to the regulatory authority, the CPUC, and program administration is through the investor-owned utility companies. The NYSERDA pre-installation review process includes both the submission of formal documents and less formal discussions and review with program staff. Although the two jurisdictions vary in their approaches, both provide avenues for sharing feedback between program staff and ex ante reviewers.

Although the two pre-installation review strategies differ in their implementation, the authors perceive the overall impression that program administrators and evaluators find the early review beneficial, if not easy.

The Ontario Power Authority (OPA) M&V protocols require pre-retrofit engagement of evaluators for certain projects (Messenger, 2007). The protocols differ from those in New York in at least three ways: (1) They specify that evaluators conduct the pre-retrofit metering, whereas to date the evaluators have only advised on logging practices in New York; (2) OPA savings are based on pre-retrofit production levels, whereas post-retrofit use is the basis in New York; and (3) administrator concern about free ridership (Reed, 2012) on large projects has led OPA to pilot an approach that assesses likely free ridership prior to incentive award.

Lessons Learned and the Future of Pre-installation Review

The NYSERDA IPE pre-installation reviews have resulted in adjustments in calculated savings and the addition of data points that enhance the level of rigor of program-required M&V. It has led to early baseline research to encourage consistency between program and evaluation baseline definitions. Pre-installation reviews have helped the evaluators by allowing the evaluation engineers to inspect equipment in its pre-retrofit state, and they have helped interview participants near the time of project installation to better estimate baseline. These reviews have also increased the depth of engagement with

program facilitators. Program staff members have reported that the process has been educational and that they are, in at least selected instances, applying the logic used to characterize the projected energy savings in the reviewed projects to other projects.

These are the lessons learned:

- Communication is key to the success of the pre-installation review process
- Clear procedures and guidance are needed to successfully implement a collaborative process between the program team and the evaluators.

Assessment of free ridership is not currently in the scope of the pre-installation review. Other jurisdictions are known to do this in at least some circumstances and it may be considered for addition to the process in the future. Incorporating free ridership early would benefit the evaluation in two ways: (1) It would allow interviews regarding customer decision-making as close as possible to the time the decisions actually are being made; and (2) it could ensure that the line between baseline definition and free ridership is distinct.[4] There are trade-offs. NYSERDA, by policy, cannot exclude a customer from receiving a program incentive because they are or might be a free rider. This policy differs from some other administrators. For this and related reasons the evaluators cannot share free ridership information on specific participants with NYSERDA program administrators. Researching this information prior to installation and keeping it separate would be a challenge from an analytical and managerial perspective, but it would not be impossible. One of the difficulties in evaluating this industrial efficiency program is that the participants can have a difficult time articulating the alternative solutions sufficiently to quantify them with confidence. Specifically, site staff members sometimes find it easier to explain what they otherwise *would* have done absent the program but find it harder to distinguish what other lower-efficiency alternative they otherwise *could* have done in capacity expansion projects. For this reason it might be worthwhile to explore evaluation approaches that use combined factors for evaluated gross savings net of free ridership. Such an approach, using the term "modeled partial net" savings, is used for one of NYSERDA's other evaluations.

For example, a dairy product manufacturer expanded their capacity by more than 100%. Analysis of pre- and post-retrofit billing and production data demonstrates that the expansion has reduced the energy use per ton by more than one-third. While this is a great success story, it is difficult to speculate on the least efficient alternative the manufacturer could have considered. There is no industry standard practice for this application. The evaluators assumed the theoretical baseline to be a similar plant purchase and conversion to the one made by the owner a few years ago and that resulted in the pre-retrofit plant. A modeled partial net assessment, in contrast, would have ignored that strained theoretical condition, and then simply asked the customer directly what they *would* have done to deliver the new capacity absent NYSERDA's program, and modeled that as the program net baseline. The authors believe that the answer to this question is easier to give and more accurate than the answer to the question "what is the less efficient thing you could have done?" It also is more important to the analysis of net program savings.

In the future, the evaluators intend to compare the realization rates of those projects with pre-installation involvement to those without it. The process reduces impact evaluation uncertainty as some factors that could have differed between the program team and the evaluators unequivocally have converged. As a result, the authors are confident that for the individual projects evaluated, the early intervention will result in better (closer to 1.0) realization rates.

[4] It can be difficult to articulate free ridership questions that precisely distinguish between the least efficient action the customer could have taken, what they would have done absent the program, and what they actually did regarding unique process measures for which there is no obvious industry norm. Generically phrased questions do not always work. With industrial new construction and capacity expansion in particular the engineer and social scientist need to work closely to ensure that the evaluation neither double penalizes a project (overlapping penalties = high free ridership + a very efficient baseline both due to the same alternative described by the customer) nor excessively credits a project for the reverse.

Policy Ramifications

The paper has made several assertions and raised issues that go beyond procedure and have policy ramifications. To summarize policy issues the pre-installation evaluation scope has addressed and anticipated:

- Integrating the day-to-day operations of administrators with the evaluators has the consequence of educating administrators and giving them feedback in a sort of instantaneous process evaluation (good) and/or introducing the potential for bias in evaluation (bad);
- NYSERDA evaluators are willing to commit to a baseline characterization likely 3 years before ex post evaluation;
- NYSERDA evaluators are willing to allow program administrators to ignore the evaluators' findings in reporting savings and paying incentives. Practically speaking, this has not happened often, but the policy allows it.
- The evaluators are unwilling to commit to energy savings estimates or any bounds to them due to pre-installation review.
- Free ridership is not part of the scope.

Summary

Pre-installation review by the evaluators in large complex industrial projects can be a powerful tool to mitigate uncertainty associated with impact evaluation. Although this process does not eliminate disagreement and it requires additional resources, it can be a cost-effective approach, especially for programs that already have M&V requirements. It can also improve performance measurement quality both for program administrators and for the evaluators. Further, this pre-installation review appears to be a good educational tool for early feedback.

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